MARKED-UP SPECIFICATION

[0001] DIGITAL CAMERA SYSTEM HAVING LENS TO BE REPLACED [LENS-INTERCHANGEABLE DIGITAL CAMERA SYSTEM]

[0002] This application claims benefits of Japanese Application No. 2003-135005 filed in Japan on May 13, 2003, the contents of which are incorporated by this reference.

[0003] BACKGROUND OF THE INVENTION

[0004] FIELD OF THE INVENTION

[0005] The present invention relates to a lens-interchangeable digital camera system and a digital camera, interchangeable lens and camera body thereof.

[0006] RELATED ART STATEMENT

[0007] A conventional digital camera includes an optical low-pass filter (called optical LPF hereinafter), containing crystal or the like having a double refraction characteristic, in the front of the surface of an image pickup element in order to reduce false color (such as moiré) of a high frequency component of a shot image. A single lens reflex digital camera system has been provided in which a lens (lens barrel) is interchangeable with respect to the camera body. Image pickup elements having different numbers of pixels, that is, having different pixel pitches are built in multiple bodies of the lens-interchangeable digital camera system. Furthermore, multiple kinds of interchangeable lens can be attached to the body.

[0008] An optical LPF having thickness corresponding to the pixel pitches is provided in the front of the surface of the image pickup element having different pixel pitches as described above in the single lens reflex camera body.

[0036] When an optical [optical filter 103] LPF 102 is not provided in front of an image pickup surface 103 of an image pickup element as shown in Fig. 10, the center luminous flux having passed through a lens 101 forms an image at a point P1 on the image pickup surface 103.

[0037] A peripheral luminous flux having passed through the lens 101 forms an image at a point P2 on the image pickup surface 103. However, when the optical LPF 102 is provided in front of the image pickup surface 103 of the image pickup element, the center luminous flux having passed through the lens 101 forms an image at a point P1' behind the image pickup surface 103. The peripheral luminous flux having passed through the lens 101 form an image at a point P2' behind the image pickup surface 103. When the LPF 102 is thicker, the luminous flux forms an image in a more rear direction. In other words, the effective optical path length of a luminous flux to the image-forming position depends on the thickness of the optical LPF.

[0038] On the other hand, the optical length generally differs between a luminous flux incident on the center of the photographic screen and a luminous flux incident on the periphery of the photographic screen in a photographic optical system of a digital camera, generating a field curvature aberration as a result. The difference in optical path length of the center and periphery of the photographic screen can be corrected by providing the photographic optical system with an optical characteristic for canceling the curvature of field to correct the curvature of field as a result.

[0039] However, when the principle of the aberration correction is applied to a lens-interchangeable, single-lens reflex digital camera, problems as follows may occur. That is to say, in a single-lens reflex digital camera system including a first camera body having a first optical LPF and an interchangeable lens designed for

and the like. The optical LPF 8B is a second optical low-pass filter arranged in the front of the surface of the image pickup element. The compensating optical element 9 is a compensating optical system. The camera side mount portion 3 is common to the first camera body 11A and has a camera side mount surface 3a, which can be engaged with the lens side mount surface 4a.

[0051] The image pickup element 5B is a 4/3 type image pickup element similar to the reference image pickup element 5A but has a pixel pitch δ1, which is a second pixel pitch and is different from the reference pixel pitch δ0. A subject image formed on a photoelectric conversion surface 5Ba is converted to electric image pickup signals as well. The photoelectric conversion surface 5Ba is an image-forming surface of the image pickup element 5B.

[0052] The optical LPF 8B is a filter thinner than the optical LPF 8A and contains crystal or an LN element having a double refraction characteristic and having a thickness corresponding to the pixel pitch δ1 of the image pickup element 5B and further contains infrared absorbing glass. The optical LPF 8B has substantially the same predetermined refractive index as of glass. The optical LPF 8B is also disposed between the lens mount portion 3 and the image pickup element 5B.

[0053] The compensating optical element 9 is an optical member constituted by glass <u>and the like</u>, which does not have a double refractive characteristic but has substantially the same refractive index as of the optical LPF 8A. The compensating optical element 9 is attached and built in the second optical LPF 8B so that the image-forming position of a subject luminous flux by the interchangeable lens barrel 12 does not displace from the photoelectric conversion surface 5Ba of the image pickup element 5B. Furthermore, the aberration including the curvature-of-field aberration does not occur. In other words, the compensating optical element 9

[0111] The compensating optical element 9 of the second camera body 11B side has the amount of thickness equal to the decreased amount of thickness of the optical LPF 8B. Thus, the image pickup unit 15A of the first camera body 11A and the image pickup unit 15B of the second camera body 11B can take up the same spaces in the respective camera bodies. Therefore, the commonality of the constructions of the first and second camera bodies can be achieved easily.

[0112] The reference pixel pitch δ0 is 7 μm in this embodiment. A method for setting the reference pixel pitch will be described below.

[0113] As described above, the thickness of an optical low pass filter is determined based on the pixel pitch of an image pickup element. However, even with the same pixel pitch, the thickness of the optical low pass filter depends on the material. As shown in Fig. [10] 9, the thickness significantly differs between the low pass filter containing crystal as a first material and the low pass filter applying an LN element as a second material. The number of pixels shown in Fig. [10] 9 is for a 3/4 type image pickup element.

[0114] On the other hand, a thin optical low pass filter is preferably used for reducing the size of a camera. However, a much thinner optical low pass filter may be difficult to produce and may be easily destroyed, which is not preferable. An optical low pass filter containing an LN element for the image pickup element having the pixel pitch δ lower than 6.31 μm is difficult to produce.

[0115] Therefore, a pixel pitch larger than the pixel pitch corresponding to the lowest thickness, which can be produced with the second material, an LN element, is set as the reference pixel pitch. Then, by forming the optical low-pass filter in accordance with the reference pixel pitch by using the first material, crystal, the optical low pass filter can have the lowest thickness even for the camera bodies having different pixel pitches.